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**LEVERAGING KNOWLEDGE MANAGEMENT TOOLS
TO SUPPORT SECURITY RISK MANAGEMENT IN THE
DEPARTMENT OF HOMELAND SECURITY**

by

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December 2011

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SECURITY RISK MANAGEMENT IN THE DEPARTMENT OF HOMELAND
SECURITY**

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ABSTRACT

This thesis examines Knowledge Management (KM) initiatives at the Canadian Institutes of Health Research (CIHR), the United Kingdom (UK), and the National Aeronautics and Space Administration (NASA). The first goal was to identify existing KM approaches that would foster higher levels of knowledge sharing and collaboration among security risk management practitioners within Department of Homeland Security (DHS) agencies to enhance risk-informed decision-making activities. Through the analysis of the three case studies, it was discovered that organizational culture, more than any particular KM process or enabling technology is responsible for moderating the level of knowledge sharing. The KM strategies, policies and implementation mechanisms explored in the three case studies are good models for DHS to consider in order to reduce agencies' uncertainty, aiding decision making and bolstering effectiveness. The Risk Knowledge Management System (RKMS) called for in the DHS Integrated Risk Management Directive will require similar implementation and support structures for DHS to overcome the cultural, process, security, and funding obstacles experienced by the United Kingdom, Canada, and NASA. By using these case studies as models and reflecting on their experiences, DHS will be better positioned to effectively implement and adopt proven KM policies on an agency-wide basis.

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LIST OF ACRONYMS AND ABBREVIATIONS

BKMS	Biodefense Knowledge Management System
CIHR	Canadian Institutes of Health Research
DHS	Department of Homeland Security
DHS S&T	DHS Science and Technology Directorate
IT	Information Technology
GKIMN	Government Knowledge and Information Management Network
GAO	U.S. Government Accountability Office
HSIN	Homeland Security Information Network
JBL	NASA's Jet Propulsion Laboratory
KIM	Knowledge and Information Management
KM	Knowledge Management
KT	Knowledge Transfer
LLIS	Lessons Learned Information System
LLNL	Lawrence Livermore National Laboratory
NASA	National Aeronautics and Space Administration
NEN	NASA Engineering Network
NISAC	National Infrastructure Simulation and Analysis Center
NPIA	National Policing Improvement Agency
RKMS	Risk Knowledge Management System
RM	Risk Management
RMA	DHS, Office of Risk Management and Analysis
UK	United Kingdom
US	United States

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I. INTRODUCTION

A. PROBLEM STATEMENT

The Department of Homeland Security does not have a robust Knowledge Management (KM) system to support its risk-informed decision-making¹ processes. DHS Directive 007-03 Integrated Risk Management specifically highlights this gap and calls for the creation of a “Risk Knowledge Management System” (RKMS) to “facilitate the sharing of methodologies, analysis and data across the homeland security enterprise.” The absence of a robust KM system used to support risk-informed decision making inhibits DHS’s ability to leverage existing stocks of knowledge to support risk assessments and development of risk mitigation measures. The prevalence of this gap across DHS organizational elements agencies leads to potential duplication of effort or decisions based upon a limited subset of the knowledge available across the DHS Enterprise.

One significant limitation of DHS’s current knowledge sharing practices is the barriers it creates for those who maintain stocks of knowledge to gain even a partial understanding of who the consumers of that knowledge are and how to collaborate with those users. Conversely, it is difficult for the potential users of that knowledge to know what stocks of knowledge others maintain and how to access those stocks. This lack of understanding concerning knowledge stocks throughout the agency reduces overall risk-informed decision-making effectiveness and efficiency. This lack of understanding about knowledge stocks creates significant challenges to working effectively on Homeland Security risk management initiatives within DHS headquarters and component agencies.

Given the relatively few number of terrorist incidents within the United States, security risk management in Homeland Security is highly dependent on the judgments of experts and results of modeling and simulation in lieu of a rich historical dataset. DHS

¹ “Determination of a course of action predicated on the assessment of risk, the expected impact of that course of action on that risk, as well as other relevant factors” (Department of Homeland Security, 2010, p. 33).

has conducted, or sponsored a number of studies, reports, and other efforts to fulfill the knowledge requirements for risk-informed management initiatives. Unfortunately, the collective knowledge gained from these efforts cannot be fully leveraged by the DHS risk management community not only because of a lack of understanding about existing knowledge stocks but also because of access issues. The studies managed within DHS Headquarters and component agencies are typically stored on local, independent computer systems instead of an enterprise KM system. This distributed storage system keeps knowledge siloed within DHS, which hinders the sharing of that knowledge and limits collaboration. This storage approach also makes it nearly impossible to conduct a “DHS literature review” to assess what resources exist and where there are gaps.

These access barriers also inhibit security risk management practitioners from reusing existing knowledge and building upon the DHS knowledge stocks. In some cases, this lack of access to existing knowledge could lead agencies to sponsor duplicative studies, wasting considerable time and money. These barriers also make it challenging to evaluate how DHS’ risk management activities are progressing in terms of sharing knowledge to better support risk-informed decisionmaking.

In addition, to the physical and technical challenges to sharing information, the organizational culture and multiple agency structure of DHS present barriers to knowledge sharing. Although DHS has instituted a wide variety of committees and workgroups, these collaborative venues are not guided by cross agency KM objectives.

B. RESEARCH QUESTIONS

How can existing strategies be used to leverage KM methods and supporting tools to foster higher levels of knowledge sharing and collaboration among security risk management practitioners within DHS agencies to enhance risk-informed decision-making activities?

What KM implementation approaches would be suitable for the DHS risk management community of practice and for a broader application at the departmental level to advance DHS as a learning organization?

C. SIGNIFICANCE OF RESEARCH

This thesis will address an application of KM that is not currently addressed in the literature. As noted above, there is a wealth of information on KM but there is a gap on KM's application in the security risk management field of practice. This evaluation will highlight a potential new area for future research that may be explored internally by the DHS Science and Technology Directorate. Alternatively, the DHS Risk Steering Committee organized by the DHS Office of Risk Management and Analysis may explore additional immediate policy to implement solution sets recommended from this research. Given the recent refocusing and mission prioritization from the 2010 Quadrennial Homeland Security Review and the increasingly budget constrained environment, this research may offer timely recommendations with immediate synergistic benefits and long-term cost savings.

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II. BACKGROUND

Knowledge theory work dates back decades with Knowledge Management (KM) effectively emerging as a distinct field in the mid-1990s, drawing theories and practices from disciplines such as organizational science, management science, and management information systems (Koenig, 2004). KM enjoys a rich multidisciplinary field of literature, but it is not exhaustive and significant gaps are apparent, particularly with reference to its more recent applications. The existing literature primarily reflects KM's early focus as an enabler to business (for competitive advantage). Consequently, it is written from an academic or business perspective and does not fully explore the theory's broader applications. Beyond the many KM books, there are a considerable number of journals devoted specifically to KM (i.e., Electronic Journal of Knowledge Management, Journal of Information and Knowledge Management, Journal of Knowledge Management, and Journal of Knowledge Management Practice).

Recent literature is beginning to reflect KM's gradual adoption outside of business as pockets of federal government have implemented KM practices and systems. Perhaps more important is what was not found in the literature despite the clear value of such a connection. Specifically, a review of current literature does not reveal any ties between KM and Security Risk Management (RM) in the Department of Homeland Security (DHS). The DHS Risk Lexicon defines risk management as the “process of identifying, analyzing, assessing, and communicating risk and accepting, avoiding, transferring or controlling it to an acceptable level considering associated costs and benefits of any actions taken” (Risk Lexicon 2010, p. 30). Best practices within the KM field would be particularly useful in reducing the uncertainty inherent in RM challenges within DHS.

A. KNOWLEDGE

Much of the KM literature addresses foundational level concepts, such as knowledge. Davenport and Prusak (1999, p. 5) offer the following definition of knowledge:

Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms.

In their discussion, Davenport and Prusak suggest that this definition of knowledge highlights characteristics that make knowledge valuable, as well as characteristics that make knowledge hard to manage effectively. While there is no consensus on the definition of knowledge in the literature, their definition introduces the key aspects of knowledge referenced by other authors (McNabb, 2007; Hawryszkiewycz, 2010; & Wild, 2008). In addition, this definition highlights that the study of knowledge is multifaceted, dealing with people, organizations, culture, processes, and documents.

There is widespread agreement among scholars that knowledge is distinguishable from information or data. Hawryszkiewycz (2010) places knowledge along a spectrum in Figure 1. As with Davenport and Prusak (1995), Hawryszkiewycz (2010) sees knowledge within a hierarchy. At the lowest level, data are facts that are not necessarily organized or framed within a context. One-step above data is information (data that is organized). Davenport and Prusak (1995, p. 3) describe information as a “message, usually in the form of a document, or audible or visible communication”. For them, data is transformed into information by adding meaning or value through: contextualizing, categorizing, calculating, correcting, or condensing (Davenport & Prusak, 1995). Both Davenport and Prusak (1995), and Hawryszkiewycz (2010) associate knowledge with enabling decisions or actions and cite the need for humans to transform information to knowledge.

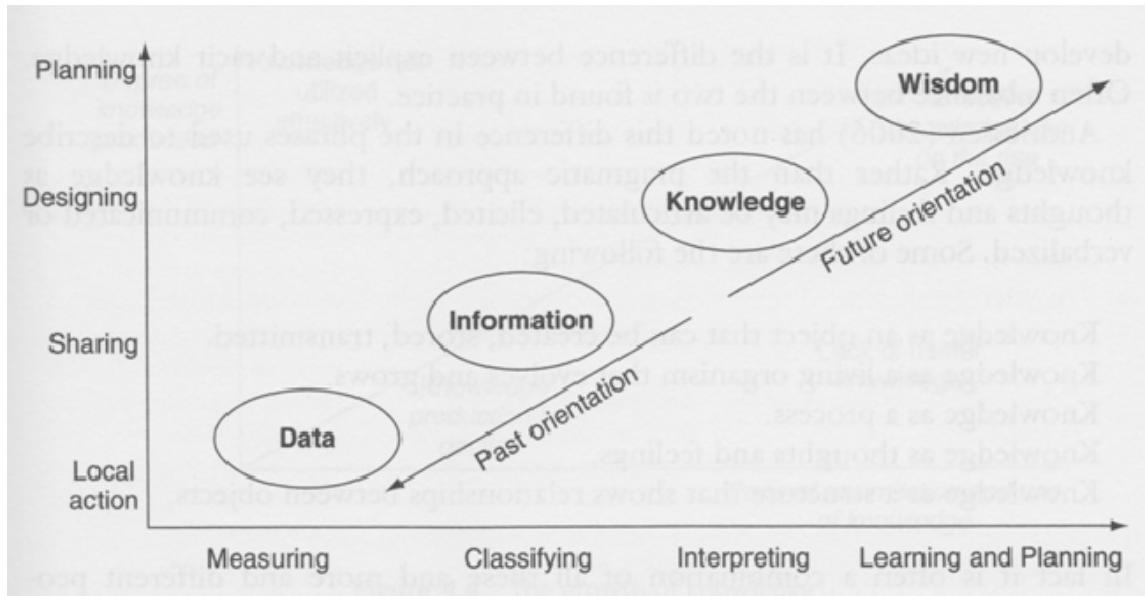


Figure 1. Knowledge spectrum (From Hawryszkiewycz, 2010).

1. Knowledge Distinction

One of the most often cited authors in the KM literature, Ikujiro Nonaka (1991) draws a crucial distinction between tacit and explicit knowledge. Knowledge within a person is tacit. Nonaka argues that tacit knowledge is hard to communicate to others because of its highly personal and informal nature. To explain this challenge, Nonaka quotes philosopher Michael Polanyi, “We can know more than we can tell” (1991, p. 98). In addition to the technical skill component of tacit knowledge, Nonaka identifies a “cognitive dimension,” “...of mental models, beliefs, and perspectives so ingrained that we take them for granted, and therefore cannot easily articulate them” (1991, p. 98). In contrast to tacit is explicit knowledge. Explicit knowledge does not reside within an individual. Explicit knowledge is contained within things (i.e., computer programs, scientific formulas, technical schematics, etc.). Nonaka describes explicit knowledge as “formal and systematic,” arguing that it is more easily shared (1991, p. 98).

In relation to this distinction between tacit and explicit knowledge, Hawryszkiewycz (2010, p. 74) noted differences in the phrases used to describe knowledge:

Knowledge as an object that can be created, stored, transmitted.

Knowledge as a living organism that evolves and grows.

Knowledge as a process.

Knowledge as thoughts and feelings.

Knowledge as structure that shows relationships between objects.

This list of phrases characterizing knowledge is indicative of the variance found within the literature regarding different approaches to knowledge.

B. APPROACHES TO KNOWLEDGE

The focus on tacit versus explicit knowledge illustrates a divide in the approaches to KM within the literature. In Perspectives on Managing Knowledge in Organizations, Chun Wei Choo (2003) compared two influential knowledge management frameworks based upon a ranking of the five most frequently cited authors and publications in the KM field. Choo's analysis indicates that Inkuiro Nonaka and Thomas Davenport are the two most often cited authors in the field of KM. Their respective books, *The Knowledge Creating Company* by Nonaka and Takeuchi and *Working Knowledge* by Davenport and Prusak, offer two distinct approaches for organizations to apply when managing their knowledge. In a separate study of the 50 most cited works in KM academic literature from 1995–2001, Koenig (2004) also found these two authors and these books to be the most often cited.

Choo's comparison of these two perspectives offers a general overview of two "camps" that have formed within the literature (2003). These different perspectives are often attributed to cultural differences among the authors and their worldviews. Nonaka and Takeuchi's background and use of KM examples within Japanese companies are associated with Eastern culture. "For them, the tacit knowledge of individuals lies at the heart and is the prime mover of knowledge creation in organizations" (Choo, 2003, p. 211). In contrast, Davenport and Prusak's views align with the traditions of western management. They offer "a more pragmatic definition of organizational knowledge, and a more operational view of managing knowledge" (Choo, 2003, p. 211). Rather than

focusing on knowledge creation, Davenport and Prusak explore “how organizations can capture, codify, and transfer knowledge, with a particular emphasis on knowledge sharing” (Choo, 2003, p. 211). Choo argues that “both models recognize the complex, dynamic nature of creating, sharing, and using knowledge, and each recommend a different structural approach to managing this complexity” (2003, p. 211).

Recognizing that while the majority of the published work on KM has appeared in the last 15 years, it has origins that are much older, Grant (2007) chose to explore the writings of Michael Polanyi in Personal Knowledge: Towards a Post-Critical Philosophy (1958) and The Tacit Dimension (1966). Like Choo (2003) and Koenig (2004), Grant found that Polanyi was one of the most frequently cited sources in KM on tacit and explicit knowledge (2007). Interestingly, Grant’s review of 60 papers from three major KM journals revealed frequent misinterpretation of Polanyi’s fundamental concepts by some authors (2007). Based upon the review of Polanyi’s work, Grant questions and rejects an “either/or view of tacit/explicit knowledge” (2007, p. 178). Grant asserts that Polanyi’s view of knowledge is a “continuum between tacit and explicit” knowledge (2007, p. 178). Grant argues against the following extreme ends of the spectrum: (1) “all knowledge is tacit” and “explicit knowledge is just information,” and (2) which Grant labels as “Technocratic,” which focuses on information systems to convert tacit knowledge to explicit knowledge through codification (2007, p. 178). This is a departure from the work of Easterby-Smith and Lyles (2003, p. 425), which argues against this continuum view, since “even the most explicit knowledge is underlain with tacit knowledge,” using two sides of the same coin as an analogy.

C. WHAT IS KNOWLEDGE MANAGEMENT (KM)?

Like knowledge, KM definitions vary in the literature. While there is no single definition or approach, there is strong agreement that KM involves people, processes, activities, and technology within an environment or organization, to enable knowledge creation, communication, and sharing (Lehaney, B., Clarke, S., Coakes, E., & Jack, G. 2004). The following list of KM objectives from KPMG The Power of Knowledge: A Business Guide to Knowledge Management (1999, p. 2) is useful in understanding KM.

Knowledge management is about:

- supporting innovation, the generation of new ideas, and the exploitation of the organization's thinking power;
- capturing insight and experience to make them available and useable when, where, and by whom required;
- making it easy to find and reuse sources of know-how and expertise, whether they are recorded in physical form or held in someone's mind;
- fostering collaboration, knowledge sharing, continual learning and improvement;
- improving the quality of decisionmaking and other intelligent tasks;
- understanding the value and contribution of intellectual assets and increased their worth, effectiveness, and exploitation.

1. Rise of KM

The literature points to a confluence of events and trends that have contributed to the rise of KM. The shifting of western economies from manufacturing to services and the development of information technology have, in particular, led to the rapid expansion of information dissemination and availability to the point where we have become an information society. During the same period, business success has been increasingly dependent on its adaptability to embrace change and proactive approaches able to address market shifts (Lehaney, B., Clarke, S., Coakes, E., & Jack, G. 2004). Steward (1997, p. 6) is often cited as articulating the business case for KM, stating, "Knowledge management for an organization is critical, for knowledge is emerging as the pre-eminent economic resource above raw materials, and often money...fundamental sources of wealth are knowledge and communication rather than natural resources and labor."

D. INFORMATION TECHNOLOGY (IT) KM ROLE AND OPPORTUNITIES

Throughout the literature, there seems to be general agreement that IT has a significant role in enabling or facilitating RM, although there is no clear consensus on exactly how IT tools can be implemented most effectively (Wild, R., & Griggs, K.,

2008). IT support to KM has largely focused on organizing, formalizing, and distributing organizational (explicit) knowledge. Today, this type of IT support is handled by an array of “secure networks, intranets, webbased technologies, database systems, and a wide variety of communication, messaging, browsing and retrieval tools,” which span the KM objectives in Figure 2 (Wild, R., & Griggs, K., 2008, 495). The remaining phases of the KM Life Cycle (generation, application, and evolution) have proven more difficult to support, much less perform with IT systems.

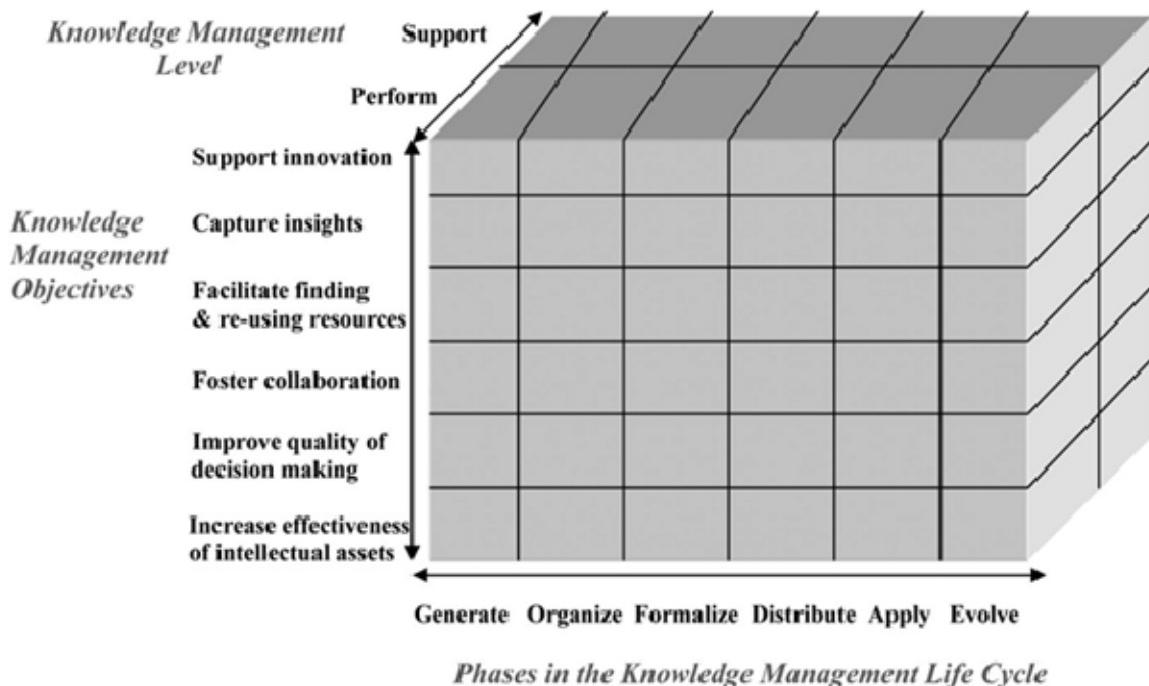


Figure 2. KM objectives and phases (From Wild, R., & Griggs, K., 2008).

E. KM IN THE PUBLIC SECTOR

McNabb (2007) establishes a connection between data processing, information management, reinventing government, e-government, federal requirements for enterprise architecture, and KM. Within this context, McNabb defines KM as “a set of processes, practices, and management philosophies that exist to collect, process, store, and make available the organizational knowledge that enables government agencies to be more proficient and competitive in the delivery of public services (2007, p. 22). McNabb

(2007) posits that investments in KM systems can contribute to e-government, homeland security, collaboration, and other important government programs.

While discussing the benefits of existing KM systems in government agencies and private industry, both McNabb (2007) and Fountain (2001) identified fundamental differences in rewards, disincentives, and external factors that influence KM system development and implementation between sectors. Looking at the focus of KM systems illustrates this disparity most clearly: while the private sector generally seeks competitive advantage (internal advantage), public sector KM initiatives focus on generating value for external stakeholders (i.e., other agencies, the public, and compliance with federal mandates). McNabb also quotes a Defense Contract Management Agency spokesperson describing how greater application of KM systems would help to address information sharing difficulties in the federal government.

The Federal government is a vast storehouse of knowledge, and its employees are experts in thousands of subjects, from AIDS research to weather prediction. The real challenge is building an environment for the freer exchange of this collective intelligence among federal agencies; an exchange among Federal, state and local governments; and a more accessible exchange between the knowledge stores of the Federal government and citizens. The ability to leverage these extensive knowledge stores and increase the intellectual capacity of agencies to quickly find solutions improve decision-making and effectively respond to other government organizations and citizen is crucial to achieving a major improvement in the Federal government's performance and value to the citizen (2007, p. 170).

While discussing the benefits of existing KM systems in government agencies and private industry, both McNabb (2007) and Fountain (2001) identified fundamental differences in rewards, disincentives, and external factors that influence KM system development and implementation between sectors. Looking at the focus of KM systems illustrates this disparity most clearly: while the private sector generally seeks competitive advantage (internal advantage), public sector KM initiatives focus on generating value for external stakeholders (i.e., other agencies, the public, and compliance with federal mandates).

F. FAILURE FACTORS IN REPOSITORY- BASED KM APPROACHES

While much of the literature discusses benefits and successes of KM systems for organizations, Weber (2007) identified potential reasons that KM approaches had failed:

KM approaches may fail...	Discussion:
When they attempt to create a monolithic organizational memory	These organizations are often highly distributed with conflicting goals
If they do not integrate people, processes, and technology	Each of these factors are limited acting independently
If designed without input from all stakeholders	This often ignores community processes and organizational culture
When contributors do not know what knowledge to contribute	Users often submit useless artifacts or fail to submit anything
Due to lack of leadership support	Skepticism spreads throughout the community
When users are afraid of the consequences of contributing	Often concerns job security, being subject to criticism, or evaluation
When they store information in unrestricted textual representations	This format may be long and difficult to interpret, lacking process context
If relying on inadequate technology	These tools may only deal with data and information vice knowledge
When they are outside of the process context	Forces users to divert from normal work activities
That ignore impediments to knowledge transfer	Potential knowledge re-users do not know how to extend knowledge to different contexts
That do not enforce managerial responsibilities	Lacks control over knowledge being shared or reused
That do not oversee the quality of stored knowledge	Users cannot find valuable knowledge amongst the total
That do not promote collaboration	Collaboration is crucial means of learning and sharing
That are not able to show measurable benefits	Loose management support without demonstrating effectiveness
Because users do not perceive value in contributing	The value of KM is usually felt by the organization more than by individual contributors

Table 1. Knowledge management failure factors (From Weber, 2007, pp. 334–335)

G. ORGANIZATIONAL CULTURE

There is modest consensus in the literature that organizational culture is a key component of KM. Within this school of thought, many argue that organizations should take a hard look at their organizational culture prior to developing a knowledge initiative. Despite this level of agreement, there is less known about creating an effective culture for KM. Oliver, et al. (2006) referred to a classic study that found 164 different definitions of culture in the literature. Within these culture definitions, common themes emerge: “the group or the collectiveness, a way of life, and the learned behaviors, values, knowledge and perceptions of people” (Oliver & Kandadi, 2006, p. 7). More specifically, organizational culture can be described as “the sum of shared philosophies, assumptions, values, expectations, attitudes, and norms that bind the organization together” (Oliver & Kandadi, 2006, p. 8). It is important to note that the cultural features of an organization may deviate significantly from the cultures of societies in which the organizations are located. This aspect of uniqueness from the larger society enables organizations to shape their own culture. Oliver, et al. (2006, p. 8) describe a knowledge culture within an organization to be “a way of organizational life that enables and motivates people to create, share, and utilize knowledge for the benefit and enduring success of the organization”.

H. LITERATURE ON KNOWLEDGE MANAGEMENT AND DHS

A review of the literature revealed only limited discussion of KM in DHS and only a small portion of that related to risk management, as discussed in the problem statement in Chapter I. However, the literature did reveal that use of KM as a term has steadily increased from 2009 to 2011. The DHS Integrated Risk Management 007–003 issued 28MAR2011 most specifically related to this study. It calls for the establishment of a RKMS as a responsibility of the Director, Office of Risk Management and Analysis (RMA). More generally, the DHS Science and Technology Directorate Command, Control and Interoperability Division (CID) website, lists KM as one of the five CID program areas: Basic/Futures Research; Cyber Security; Knowledge Management Tools; Office for Interoperability and Compatibility; and Reconnaissance, Surveillance, and Investigative Technologies. Most recently, a Homeland Security Information Network

(HSIN) brief *HSIN and OPS – A Critical DHS Partnership for Information Sharing and Collaboration* dated 16SEP2011 lists KM prominently as a program update for HSIN Release 3.

1. DHS Affiliated KM Systems

Within the literature review, a few DHS affiliated KM systems discovered have some similarities to requirements for Homeland Security risk management. These KM systems are predominantly managed by national laboratories, and are: IT based, repository or portal centric, and focuses on highly technical information. The following are brief descriptions of these KM systems:

a. National Infrastructure Simulation and Analysis Center (NISAC– KM Portal)

The KM Portal is a web application for NISAC analysts, modelers, and administrators to contribute and share information. It integrates views for critical infrastructure information, including documents, reports, models, simulations, analyses, data, project and program information, and policies. Access can be granted to external partners upon request.

b. Biodefense Knowledge Management System (BKMS)

The BKMS is funded and managed by the DHS Science and Technology Directorate (DHS S&T) and is operated by the Lawrence Livermore National Laboratory (LLNL). BKMS is a database of biodefense related information (e.g., scientific reports, research databases, and articles) available via secure websites. A pending update to version 2.0 will add data integration and indexing element to enable users to identify intersections and correlations within the data more easily.

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III. METHODOLOGY

An appreciative inquiry approach was used to explore the existing problem space, evaluate potential solution sets from existing knowledge management approaches and recommend courses of action for implementation in DHS. Appreciative inquiry is a formalized method to explore the positive aspects of human systems to discover the best in shared experiences (Barrett & Fry, 2005). Instead of looking at gaps and failures, appreciative inquiry explores what works in an effort to continually improve or expand that success to new areas. This methodology seemed more likely to identify smart practices from existing applications of KM that could be applied to a specific application like Homeland Security risk management. Appreciative inquire is a method to move past the status quo and into new areas in an innovative fashion.

This methodology capitalized on existing information on knowledge management theories, practices and systems. This appreciative inquiry approach explored applications of KM in a similarly positioned public sector agency, as well as, international KM initiatives to identify catalysts, and supporting factors that were successful. Success was defined as addressing tacit and explicit knowledge sharing and ability to foster greater collaboration between DHS risk management practitioners.

A. SAMPLE

The following is a brief overview of the three KM initiatives studied and a discussion of how they related to the research questions. These KM initiatives were selected based upon: (1) they are publicly focused, (2) the countries are sufficiently similar to the United States from an economic development and governance perspective, (3) they are focused on sharing knowledge and enhancing collaboration, and (4) their extensive coverage in the literature.

1. United Kingdom (UK)

The United Kingdom instituted a top down KM approach through a national strategy to better position the country to capitalize on information as a national asset. Of

the three KM initiatives studied, the United Kingdom was the most recently initiated. It was hoped that this newness would be representative of the current state of practice in KM. The United Kingdom KM initiative also provided the only national level perspective. This national level perspective may offer insights that need to be considered to influence DHS as a learning organization.

2. Canada

The Canadian KM initiative focused a national priority on advancing a single sector, health care, by strengthening the linkages between medical research and medical practices. This focus on advancing the state of health care knowledge and practice offered a strong parallel to risk management in DHS and bolstering risk informed decision-making. In addition, the tie to medical grants offered a unique parallel to recent DHS efforts with academic institutions and designated Centers of Excellence.

3. National Aeronautics and Space Administration (NASA)

NASA's KM initiatives are the most mature of the ones studied. In 2000, NASA turned to KM as an approach to reduce the risk of mission failures. While NASA's efforts are focused on safety risk vice homeland security risk management, there are considerable parallels to DHS. In many ways, the DHS of today is similar to NASA in early 2000. These similarities, along with the common need to address organizational culture factors for knowledge sharing and collaboration, made a strong case for including NASA in the KM initiatives studied.

B. DATA ANALYSIS

These three KM initiatives were treated as small case studies to be explored with an appreciative inquiry approach. Barrett and Fry (2005, p. 53) emphasize that appreciative inquiry centers around two fundamental questions (as adapted to the research):

1. What in this particular setting has already made KM possible?
2. What possibilities exist, expressed, or latent, to do KM even better in the future?

For this study, the focus of Chapter IV, Analysis, and Chapter V, Findings, was an exploration of this first question, while the second question was addressed in Chapter VI, Recommendations. Within this approach, KM strategic enablers were assessed as to the extent to which they supported: (1) tacit and explicit knowledge sharing, (2) enhanced collaboration, and (3) the extent of their implementation feasibility within DHS on a qualitative low, medium, and high scale.

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IV. ANALYSIS

A. UNITED KINGDOM

In 2008, the United Kingdom released a national knowledge and information management (KIM) strategy, *Information matters: building government's capability in managing knowledge and information*, to guide their efforts as an increasingly information focused society. It recognizes KIM as a formal function of government on par with finance and communications. The strategy establishes three key strategic government actions:

- Improve the way departments manage information as a valuable asset, ensuring it is protected, made accessible where appropriate, and used effectively to inform decision making.
- Build a culture that shares knowledge more effectively, and builds capability in the handling of information of all kinds.
- Deliver this through developing the professionalism of knowledge and information management, and through supporting governance, processes and technology.

An interdisciplinary team of cross government senior leaders including representatives of the Chief Information Officers Council and the Chief Technology Officers Council that comprise the UK Knowledge Council developed this strategy. To implement the KIM strategy, the Knowledge Council created *Information matters: delivery plan for 2009–2010*. An underlying principle of this implementation plan is to recognize and leverage departments doing existing and relevant KM work to lead those activities on behalf of the government and share their findings with the Knowledge Council. In addition to the Knowledge Council, the UK National Archives has a large role in the plan, designated as the lead department for five of the twelve designated KIM initiatives.

In 2011, the UK National Archives published The United Kingdom Report on the Re-use of Public Sector Information. The reuse of public sector information (PSI) is intended to support the government, as well as the external public as part of the UK's Transparency agenda by enhancing the availability and access to public sector created information. To support PSI, the United Kingdom has implemented legislation, streamlined government licensing, and minimized Crown copyright requirements. Under this initiative, the United Kingdom is leveraging web-based technology utilizing data.gov.uk to make government datasets available to the public.

Governing the UK's Knowledge and Information Management Function are the heads of the National Archives and the Knowledge Council, supported by the Government Knowledge and Information Management Network (GKIMN) team. This GKIMN team oversees and coordinates implementation of the strategies to support the KIM Function, as well as, maintaining the GKIMN wiki. The GKIMN wiki is a secure online community for KIM practitioners that enables online collaboration within communities of practice.

To address the people side of the KIM Function, the United Kingdom has developed a Government KIM Professionals Skills Framework to inform human resource criteria under the Information matters strategy. This document establishes a common lexicon to describe core competencies for Government Strategists, Leaders, Managers, and Practitioners in the KIM Function. On the technical side, the United Kingdom has identified linked data as a best practice for “exposing, sharing and connecting pieces of data, information and knowledge using the web”. The United Kingdom recognizes that it is not enough simply to develop IT tools for KIM, but seeks to influence a culture change, by focusing on “enabling teams or communities to achieve a common business purpose.”

As an extension of the UK's Science and Technology Strategy to Counter International Terrorism (2009), the United Kingdom developed the booklet Ideas and innovation—how industry and academia can play their part. In this document, KM is highlighted as one of five Key Technologies along with biometrics, screening, physical protection, and countering improvised explosive devices of critical importance to solving

four key counter-terrorism challenges. The United Kingdom defined these challenges as: knowledge access, building a culture of sharing, and supportive governance with integrated information technology, and anticipates addressing them through innovative solutions generated by collaboration among industry, academia, and government. The United Kingdom, therefore, views KM as a tool that supports counter-terrorism efforts by enabling the government to:

- Use relevant data more effectively and more widely
- Get much closer to real-time analysis and subsequent action
- Achieve closer working and collaborative action across government
- User resources and IT systems more effectively (HM Government, 2009)

As an example of using IT systems more effectively, the United Kingdom specifically highlighted the potential of data mining in unstructured data sets to support real-time intelligence analysis as an exploration area between industry and the Ministry of Defense Counter-Terrorism Science and Technology Centre.

Given the relatively recent development of the UK's national level KIM strategy, implementation plan, Knowledge Council, and other KIM supporting elements, it is difficult to identify the overall effectiveness of these initiatives. A telling finding from a 2010 case study of three UK police forces and the National Policing Improvement Agency (NPIA) was that none of the agencies had an overarching KM strategy or policy (Seba & Rowley, 2010). From the interviews of ten senior officers at the head or director level within the four UK police organizations studied, all were aware of the importance of KM and were engaged in force-wide initiatives on knowledge sharing, however, these were not formally coordinated. Aside from the lack of a KM strategy, the study identified two additional barriers to the existing KM implementation efforts: the culture of the police forces, and the sentiment that "knowledge is power" (Seba & Rowley, p. 623). This latter barrier reflects valuable questions regarding the potential use of knowledge once it is in governmental hands and its potential application.

The United Kingdom, to date, has organized a governing entity and established a set of protocols for implementation and application of KM. The challenge, however, appears that while the theory is sound there are challenges in the implementation that are shaped by existing workplace culture and concerns specifically regarding the use and management of knowledge. The potential benefits therefore have not been fully realized.

Although the United Kingdom's national level KM approach stresses organizational changes as a key requirement, there is a significant tie to information technology (IT) as a KM enabler or solution. Much of the enabling influence of the UK's KM strategy stems from a number of larger initiatives centered on data (e.g., e-Government, Transparency, and Re-use of Public Information) and the analysis of data as a tool for managing and understanding information, as well as for effective counter-terrorism efforts. The United Kingdom's inclusive approach to KM applies it as a counter-terrorism tool and incorporates additional information security provisions to protect security sensitive information. While at the national level there are some indications of KM initiatives successfully crossing between government, industry, and academia, there has not yet been widespread adoption of KM as an approach within individual UK police forces. The United Kingdom lacks an effective local KM implementation plan as a component of the broad national strategy, and this has the potential to hinder both implementation and effectiveness. Widespread adoption of the UK's KM strategy will likely be delayed without additional enabling mechanisms that overcome local reluctance to fully engage with the approach.

B. CANADA

Unlike the United Kingdom, Canada does not yet have a national KM strategy. However, individual Canadian agencies have authored strategic documents indicating that the Canadian government views knowledge as a manageable asset. In a 2011 annual report to the Canadian Prime Minister, deputy heads were required to report out on two KM areas: treating knowledge and information as corporate assets and incorporating knowledge transfer considerations into human resource management. This report indicated that "24 out of 36 [deputy heads/agencies] have a knowledge management

approach or strategy in place, as well as complementary, supporting tools and systems to varying degrees” and that “14 out of 26 incorporate knowledge management considerations into performance management processes and succession strategies” (Canada Privy Council Office, 2011, p. 22). In 2001, Statistics Canada, Science, Innovation and Electronic Information Division conducted the country’s first statistical analysis of KM in Canada’s private sector. This study examined the use of KM practices by Canadian firms; finding nine out of ten firms surveyed using at least one KM practice (Statistics Canada, 2003).

The Canadian commitment to the integration of KM into governmental operations and decision making is best exemplified by the Canadian Institute of Health Research (CIHR). Created by the Canadian Institutes of Health Research Act of 2000, the CIHR began with a transformative mandate combining health research and knowledge translation (KT). The CIHR Act described KT broadly to include: “knowledge dissemination, communication, technology transfer, ethical context, knowledge management, knowledge utilization, two-way exchange between researchers and those who apply knowledge, implementation research, technology assessment, synthesis of results within a global context, development of consensus guidelines, and more” (Canadian Institutes of Health Research, p. 4). CIHR further defined KT in Innovation in Action Knowledge Translation Strategy 2004–2009 as “the exchange, synthesis and ethically-sound application of knowledge within a complex system of interactions among researchers and users to accelerate the capture of the benefits of research for Canadians through improved health, more effective services and products, and a strengthened health care system” (Canadian Institutes of Health Research, p. 4). This latter definition in particular highlights the active exchange between knowledge creators and knowledge users as a key aspect of Canada’s application of KT. In addition, the strategy establishes four strategic directions:

- Support KT Research – Improve the KT knowledge base and capacity for KT research.
- Contribute to Building KT Networks – Create and support networks that bring stakeholders together to enable an active exchange.

- Strengthen and Expand KT at CIHR – Integrating KT opportunities within existing programs and expand internal organizational capability.
- Support and Recognize KT Excellence Externally – Reward excellence, build excitement across KT community in Canada. (Canadian Institutes of Health Research, pp. 6–8).

Under this strategy and in support of KT research, CIHR has developed an impressive array of KT support tools (e.g., five KT Learning Modules and a book: Knowledge Translation in Health Care with accompanying presentations from the contributing authors covering the compilation of chapters) (Knowledge Translation in Health Care: Moving from Evidence to Practice). These KT support elements expand the KT knowledge base by documenting practices and guidelines, as well as raising understanding of specific KT approaches for health researchers. In addition to the personal networks that are formed on individual research projects, CIHR has developed a website, KT Clearinghouse, which has established an online community connecting researchers and serving as a repository for KT resources (Welcome to the KT Clearinghouse). To address strengthening and expanding KT, CIHR developed the End-of-grant KT. In this program, CIHR requires a tailored KT strategy to be incorporated into the researcher's published work in order to streamline the transfer of knowledge from traditional findings to practical application or policy development.

In *Knowledge to Action: An End-of-Grant Knowledge Translation Casebook*, nine case studies highlight the activities that occur at the end of the research to successfully translate the new knowledge into action. These case studies highlight the key components of strong End-of-Grant KT plans and showcase the impact of the research on Canadians. These plans include increasing the accessibility of information and require not only the traditional dissemination of findings, but also that they be made freely accessible online within six months of publication. CIHR has a separate guide to support researchers on developing strong End-of-Grant plans, making this an essential component of its funded research.

CIHR also recognizes notable KT achievements through awards and grant funding. On the CIHR KT Showcase website, researchers are encouraged to submit KT success stories and previous award winners are recognized with an emphasis placed on their KT initiatives (KT Showcase). In addition to this more formal forum, CIHR proactively compiles KT initiatives that have been recognized in the media to demonstrate the direct impact of health research on the lives of Canadians (Research Profile—Taking CIHR to Canadian Communities: The impact of effective knowledge translation).

CIHR has focused on human and cultural aspects of KM in their KT strategy and implementation mechanisms, using existing web technology to support their KT programs rather than focusing on information technology solutions to KM. CIHR's oversight and management of health research funding enables them to push KT integration initiatives that might otherwise meet resistance. CIHR has established a comprehensive array of KT support tools to raise understanding of KT approaches and enable researchers to incorporate these KT approaches into each stage of research. Aside from Canadian Parliament mandates and agency directives, CIHR has created a strong value proposition for researchers to adopt KT practices, raising the likelihood that their research will make an immediate difference in policy or practice. The multiple CIHR casebooks highlighting success stories pave the way for others to follow suit, showcasing what impacts are possible in the short term and increasing incentives for participation. The CIHR KT Showcase further highlights peer efforts and spurs innovation in KT through additional grant funding.

C. NASA

From a KM perspective, DHS currently shares many similarities with the NASA of 2001, outlined in Table 2. While neither agency had a KM strategy in place during these periods, both agencies were starting to explore KM in one form or another. Both are large agencies with annual budgets in the billions and manage multi-billion dollar projects, whose failure risks significant human lives. In addition, both agencies were comprised of a multi-disciplinary workforce, working out of offices located across the

country and often grouped by specialized functions. Finally, neither agency enjoyed an organizational culture focused on learning and knowledge sharing. The GAO identified significant cultural barriers in NASA's organizational culture and environment that inhibited continuous learning (United States General Accounting Office, 2002, p. 39). Similarly, GAO designated implementing and transforming DHS as high-risk in 2003 and while GAO has acknowledged progress in this area, it remains a high-risk area (United States Government Accountability Office, 2009, p. 49). This incomplete implementation and transformation of DHS, indicates a similarly fragmented organizational culture, whose tendencies towards learning and sharing knowledge vary across component agencies.

Comparison Criteria	NASA 2001	DHS 2011
Robust KM Strategy	No	No
Exploring KM Approaches	Underway	Starting
Technological Elements of a RM System	Limited	Modest
Organizational Culture Focused on Learning and Knowledge Sharing	No	No
Geographical Diverse Offices with Multiple Functional Centers	Yes	Yes
Multi-Disciplinary Workforce	Yes	Yes
Manage Multi-Billion Dollar Projects where Failure Poses Significant Risk to Human Lives	Yes	Yes
Total Annual Budget	\$14.5B	\$56B

Table 2. Comparison of NASA in 2001 to DHS in 2011.

To give context to this period, NASA had just finished a massive internal assessment to address failures from the Mars Polar Lander and the Climate Orbiter. That review culminated in a report, *Enhancing Mission Success*, within which, NASA grouped 165 recommendations into four areas: People, Process, Process Execution, and Advanced Tools and Technology and developed follow-on actions into five implementation themes:

- Developing and Supporting Exceptional People and Teams
- Delivering Advanced Technology
- Understanding and Controlling Risk

- Ensuring Formulation Rigor and Implementation Discipline
- Improving Communication (National Aeronautics and Space Administration, 2000).

Under these themes, NASA formed a Knowledge Management Team, consisting of members from multiple disciplines, and chartered by the Chief Information Officer to develop a KM approach. While this approach was being developed, the team also initiated a number of pilot projects to:

- Increase access to information within NASA communities through customized portals.
- Improve the capture and reuse of lessons learned.
- Make it easier to locate experts across the organization.

In 2002, the KM Team finalized the *Strategic Plan for Knowledge Management*. With this document, NASA set people at the forefront of their approach; defining KM as “...getting the right information to the right people at the right time, and helping people create knowledge and share and act upon information in ways that will measurably improve the performance of NASA and its partners” (National Aeronautics and Space Administration,, 2002, p. 6). Beyond being people centric, the plan indicates NASA’s approach to KM as an enabler, to broadly enhance performance internally and with partners. Figure 3 outlines the plan’s KM Framework consisting of people, process, and technology.

People	Process	Technology
Enable remote collaboration	Enhance knowledge capture	Enhance system integration and data mining
Support communities of practice	Manage information	Utilize intelligent agents
Reward and recognize knowledge sharing		Exploit expert systems
Encourage storytelling		

Figure 3. NASA’s Knowledge Management Framework (After National Aeronautics and Space Administration, 2002, p. 8).

1. People

As part of this strategy, NASA recognized they needed to change their organization's culture. NASA needed to do a better job capturing the tacit knowledge of their workforce, but to do this, cultural changes were needed that would encourage people to share their knowledge. One of the findings from an internal action team pointed to "...an environment where increasing time and budget pressures broke down lines of communication and prevented people from internalizing and applying previous lessons" (National Aeronautics and Space Administration, 2002, p. 3). By leveraging KM approaches, NASA hoped to "replace the existing deep-seated culture to hoard information" with culture that encourages and promotes knowledge sharing. NASA identified that a lack of resources (time and funding) allocated to knowledge-sharing activities and implicit reinforcing of the hoarding mentality as problem areas. At the time, there was no recognition or reward system for sharing knowledge. The plan identified four example approaches to develop and nurture a sharing culture through training and incentives:

- Encouraging and ensuring reciprocity for ideas shared, particularly if the sharing evolves into new research or patents.
 - Including knowledge sharing and/or mentoring goals as part of an employee's performance plan.
 - Preserving and distributing organizational knowledge.
 - Promoting career growth for those who have a history of helping others
- (National Aeronautics and Space Administration, 2002, 15).

Encouraging storytelling was highlighted as a recommended mechanism to share lessons learned within both the strategy and the corresponding GAO review. Storytelling addressed three KM challenges 1) it subtly started to counter the information hoarding mentality, spurring organizational culture change through informal interactions in small and medium sized groups; 2) it expanded the transfer of tacit knowledge; and 3) it expanded the use and exposure of positive lessons learned that was a specific suggestion

from GAO (United States General Accounting Office, 2002, p. 34). Storytelling was also being considered by the librarian at NASA's Jet Propulsion Laboratory (JPL) independently of the larger KM strategy being developed. JPL's Deputy Director, who presented the first story *Things to Keep*, readily endorsed the idea and used the opportunity to address NASA's core values and work ethics during a time of significant change in the organization. The response was surprisingly positive (for the first session), with at least one attendee stating "...the story had given them a feeling of connectedness and belonging" (Bailey, 2003). The program continued monthly, sharing knowledge and experience not typically captured in a formal report.

2. Process

In NASA's KM strategic plan, KM processes are viewed as supporting four Agency cross-cutting processes:

- Provide Aerospace Products and Capabilities
- Generate Knowledge
- Communicate Knowledge
- Manage Strategically

So, before NASA even begins to think about KM processes, they have identified two agency wide/cross cutting processes that focus on knowledge creation and transfer. The strategic plan briefly discusses the need to ensure that new KM policies and tools are understood by the workforce for use and sharing across corporate and national boundaries. This notion of across boundaries is important in that NASA sees their KM processes extending benefits to the public through improved access to products in education, technology, and science. Along with identifying critical success factors for KM processes, Figure 4, the plan acknowledges the need for balance between long-term needs (capturing knowledge) and short-term/local needs (completing tasks quickly). This balance approach is crucial to the acceptance of KM within the organization.



Figure 4. Critical success factors for KM (From National Aeronautics and Space Administration, 2002, p. 9).

3. Technology

At first glance, it may seem surprising that NASA did not focus on technological solutions as the cornerstone of their KM strategic plan. Up to 2002, most of NASA's KM tools were IT based. NASA's first KM team was at a crossroads—was the timing right to propose a dramatic shift that moves NASA's culture to the forefront and added new expenses at a time when they were four billion dollars over budget on the International Space Station (Leonard & Kiron, 2002)? They presented two options, Figure 5.

OPTION 1		
IT Budget Proposal		Total KM Allocation
2003–2005	Included additional IT projects	\$2–\$4 million
	Integrating document-management solutions and processes for accessing and archiving project information.	
	Adoption and integration of standards for exchange of engineering data between NASA and its partners.	
	Integrating a variety of systems to provide better responses to searches (when you find a document, you can contact the author, related experts, and find related discussions or material).	
	Creating decision support systems for flight project engineers.	
	Deploying state-of-the-art e-learning technologies.	
OPTION 2		
Culture Change Budget Proposal		
2003–2005		\$5.85 million
	Formal KM organization (such as a Chief Knowledge Officer or KM Program) to ensure infusion of KM practices across the organization and embedding them in the processes.	
	Ongoing operational costs for pre-existing KM systems.	
	Changes in the incentives program to encourage knowledge sharing.	
	Providing time for key employees to share and mentor.	
	Capturing key employee knowledge about implicit systems.	

Figure 5. NASA budget recommendations options (From Leonard & Kiron, 2002, p. 16).

Under the resulting approach as outlined in the strategic plan, technology is viewed as one of many ingredients to deliver KM solutions. Technology, paired with human analysis is viewed as the best large-scale method to enable people "...to capture, discover, communicate, transfer, and preserve knowledge" (National Aeronautics and Space Administration, 2002, p. 18). From an enabling standpoint, NASA's approach to technology, Figure 6, focuses on improving upon existing tools and processes, to gain efficiencies, foster collaboration, preserve and leverage knowledge, while recognizing the importance of technology acceptance by the workforce.

FOCUS	TODAY	TOMORROW
Knowledge capture	<ul style="list-style-type: none"> ▼ Poorly organized and missing knowledge ▼ No common process for knowledge capture and recapture ▼ Random publishing of technical memoranda ▼ Inconsistent use of the Lessons Learned Information System (LLIS) ▼ Irrecoverable loss of Agency knowledge ▼ Relatively unknown Agency-wide "filing scheme" (i.e., taxonomy and metadata) ▼ Lack of adoption of data standards 	<ul style="list-style-type: none"> ▼ Organized and complete knowledge ▼ Standardized approach to capturing knowledge ▼ Knowledge engineers interviewing domain experts ▼ Graphically depicted processes and tools in information models (computer-aided systems engineering [CASE] tool) ▼ An Agency-wide filing system, including content guides, data access control, and indexing scheme ▼ A workforce that understands these processes and tools
Communication among distributed teams	<ul style="list-style-type: none"> ▼ Confusion about which tools to use ▼ Teleconferences ▼ E-mail ▼ Travel ▼ Sporadic use of videoconferencing and electronic white boards 	<ul style="list-style-type: none"> ▼ Ubiquitous tool kit ▼ Reduced travel due to sophisticated multimedia tools for teleconferences ▼ Extensive use of document management and asynchronous collaboration tools ▼ A culture that is comfortable with these tools
Knowledge preservation	<ul style="list-style-type: none"> ▼ Inability to open old electronic files because of changing technology ▼ No Agency-wide approach to handling media and format obsolescence ▼ Inconsistent and incomplete backup policies ▼ Sporadic use of tools for migrating data to new technologies 	<ul style="list-style-type: none"> ▼ Preservation and accessibility of important data ▼ Common policies for preserving data ▼ Institutional tools and plans for migrating data to new technologies

Figure 6. NASA's KM technologies to support change (From National Aeronautics and Space Administration, 2002, 19).

This enabling approach to technology is significant departure from NASA's pre-2000 KM effort. Prior to the internal study and the 2002 GAO report NASA had implemented the Lessons Learned Information System (LLIS). LLIS was an agency wide web-based repository for positive or negative lessons learned. Although LLIS was readily accessible and NASA managers were required by policy to review it on an ongoing basis, there was "no assurance that lessons were being applied towards future mission success" (United States Government Accountability Office, 2009, p. 3).

With this KM strategic plan and associated actions, NASA has adopted an adaptive approach to changing conditions. They have recognized dramatic changes in their workforce and projects. With more pressure to do things faster, better, and cheaper,

they can no longer apply their traditional method of sharing tacit knowledge and experience through mentoring and apprenticeship on decades long projects. Time and budget pressures, along with an expanded array of projects, require personnel to perform immediately. To accomplish their mission, NASA must be able to create “...multidisciplinary teams, build alliances with contractors, and quickly and dynamically link to and learn from other agency activities” (National Aeronautics and Space Administration, 2002, p. 1). Rather than looking back to old solutions for new challenges, NASA’s plan positions them to leverage existing knowledge stocks, technology and innovation to prepare and support their workforce under future constraints and conditions. NASA anticipates additional benefits from promoting knowledge sharing and individual learning, with higher employee retention, high quality applicants, and a workforce focused on “...fixing the problem rather than fixing the blame” (National Aeronautics and Space Administration, 2002, p. -1).

4. KM at NASA Five to Ten Years Later

Although NASA was already pursuing KM approaches, one of the finding from the 2003 Space Shuttle Columbia Accident Investigation Board determined that “NASA’s organizational culture and structure had as much to do with this accident as the External Tank foam” (Topousis, 2009, p. 187). In 2005, after conducting research on KM implementation at the U.S. Navy, U.S. Army Company Command, the U.S. Department of Commerce and Boeing, NASA designed and implemented a new knowledge sharing system under the Office of the Chief Engineer. The NASA Engineering Network (NEN) enabled users to find and upload lessons learned, identify and collaborate within communities of practice² and search multiple information repositories from a central search engine. The NEN team also developed a capability for people to participate in the community of practice, even if they did not have access to the full resources behind the IT fire walls.

² “Communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in his area by interacting on ongoing basis” (Topousis, 2009, p. 188).

Since early 2000, NASA has continued to implement their KM strategy and enhance KM tools, like the NEN, within a larger KM framework, Figure 7. Their KM successes were recognized in 2010 by a panel of Global Fortune 500 senior executives and international KM experts as one of the 10 winners of the Global MAKE (Most Admired Knowledge Enterprises) Individual Operating Unit study.

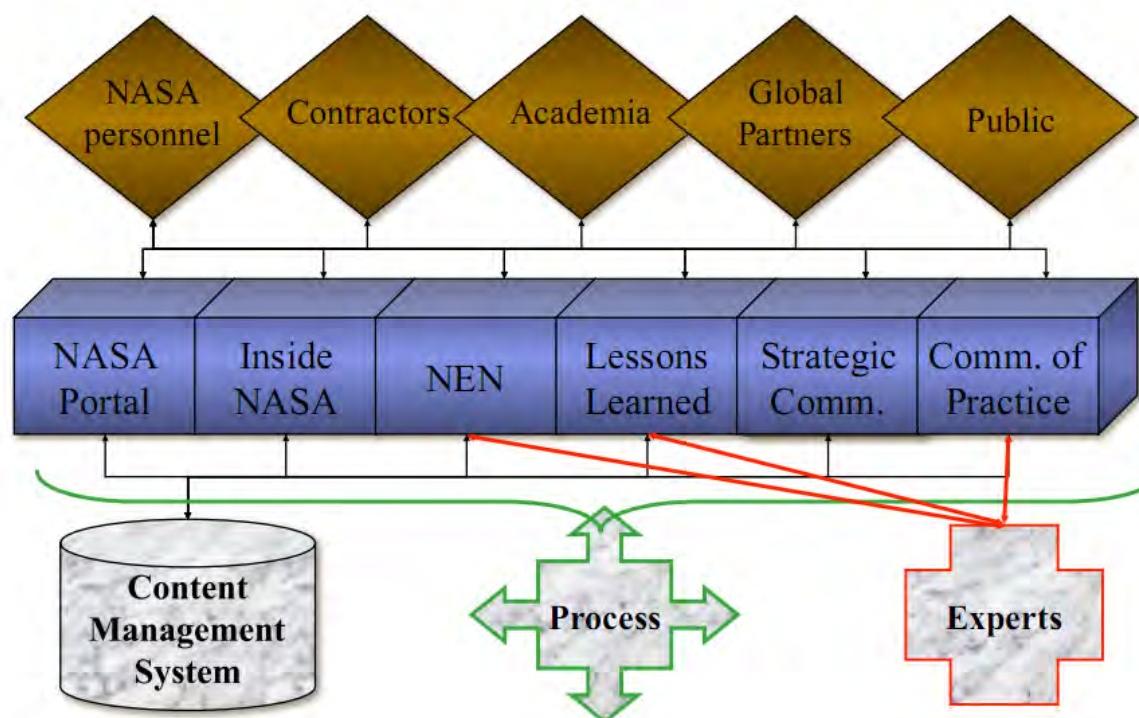


Figure 7. NASA Knowledge Management Environment (From Holm, 2009, p. 5).

V. FINDINGS

The original intent of this research was to examine existing KM strategies, methods, and supporting tools to support knowledge sharing and collaboration among security risk management practitioners in DHS and enhance risk informed decision-making activities. Through the analysis of the three case studies in Chapter IV, it was discovered that organizational culture, more than any particular KM process or enabling technology is responsible for moderating the level of knowledge sharing. The following section discusses the strategic enablers identified from the three KM case studies in light of the significant role of organizational culture.

A. KNOWLEDGE SHARING AND COLLABORATION

1. Organizational Culture

Changing organizational culture was identified across the case studies and literature review as a key element to KM implementation. Both the United Kingdom and NASA sought to influence a dramatic shift in organizational culture to promote knowledge sharing through high-level strategy documents. Lam (2005) identified cultural barriers to knowledge sharing as the causal factor in a KM initiative of an IT consulting firm. The KM initiative had: senior management support, secured funding, a high-level champion, and clear project objectives, yet it failed to overcome the organizational culture challenge where people hoard knowledge for personal gain. Liebowitz (2008, p. 47) posits that a “knowledge-sharing culture” cannot be considered in isolation from culture, organizational strategy, and organizational structure.

Organizational culture will influence the sharing of both explicit and tacit knowledge. Based on the analysis, organizational culture is a significant factor influencing collaboration in organizations. Unfortunately, this factor is one of the hardest to influence, particularly in large geographically fragmented organizations like NASA.

2. Starting with Knowledge Transfer Strategies

The Canadians' approach to Knowledge Sharing, could apply well for portions of DHS. The CIHR, infuses Knowledge Transfer into new research through grant funding requirements and supports this requirement extensively with templates, examples, guidance, and other tools. Enabling researchers to plan, develop, and incorporate a Knowledge Transfer strategy tailored to their research from the start of every new project engages potential knowledge users as partners in the research process. This requirement acts to "nudge" researchers into a collaborative or at least participatory approach. When the knowledge user is able to help define the research question and be involved in interpreting the findings, a powerful feedback loop is incorporated into the process that leads to action-oriented solutions stemming from the research. Moving Knowledge Transfer to the beginning of the research process is intended to expedite the improvement in health care by ensuring users are aware of the knowledge and facilitating their use of knowledge within the health care system, "moving knowledge into action" (Canadian Institutes of Health Research, p. 7).

Starting with Knowledge Transfer strategies will influence the sharing of both explicit and tacit knowledge. Based on the analysis, CIHR had become very successful in enhancing the collaboration between researchers and health practitioners by building in knowledge transfer strategies at the start of new initiatives. The framework for this type of process already exists and could easily be modified for Homeland Security researchers and Homeland Security practitioners.

3. Storytelling and Stories

Both NASA and CIHR implemented creative ways using storytelling to share knowledge. Each agency used a combination of personal interactions, presentations to groups, written narratives, and case studies to move beyond explicit, to tacit knowledge sharing. Not all content is ideal to convey using storytelling. It is most often used to "describe complex issues, explain events, understand difficult changes, present other perspectives, make connections, and communicate experience" (Kalid & Mahmood, 2010, p. 2). Through this socialization and experience, tacit knowledge can be created

with shared mental models (Swap, Leonard, Shields, & Abrams, 2001, p. 98). Beyond the direct benefits of sharing knowledge, storytelling enables interactions that counteract the organizational culture influences that inhibit knowledge sharing.

Storytelling is ideally suited to convey tacit knowledge that is difficult to codify. While the acts of storytelling and active listening do not in and of themselves foster collaboration, it does offer a powerful forum to positively influence organizational culture, and subsequently benefit collaboration. Perhaps the most appealing aspect of storytelling is the ease of implementation and relatively low costs.

4. Communities of Practice

Communities of practice are an effective means to capture, share and reuse knowledge. As the complexity of problems increases, they have become a prevalent strategy for collaboration and innovation at many organizations. NASA used KM approaches to support their communities of practice, and conversely, established the KM council as a community of practice to implement KM approaches across the agency. NASA found it useful to designate back up leaders to ensure that the communities of practice were being actively facilitated and working under a clear charter. These leaders and facilitators focused on efforts that enhanced the participant's ability to support NASA's mission over providing low value content (Topousis, Means, Murphy, & Yew, 2009).

Active communities of practice would provide a forum to share both explicit and tacit knowledge. Based upon the NASA examples, they have also proven effective at enhancing collaboration across functional areas in the organization. While the technological support element of communities of practice is inherently challenging to implement, the concepts and activities can be implemented with existing IT systems and organizational processes.

5. Technology as a Facilitation Tool

Current technology offers extensive benefits to KM, particularly as a tool to facilitate collaboration in a virtual space. NASA and the CIHR utilized web portals and

online forums to make explicit knowledge more accessible and enable geographically distributed people to communicate in a shared virtual environment. By enabling individuals and groups to collaborate virtually, there may be greater opportunities to bring together diverse groups. At NASA, Topousis, et al. (2009, p. 188) found “that innovation occurs at the edges of communities—for example, when thermal engineers and mechanical engineers are brought together to work a complex problem. Conversely, KM initiatives that focus too much on technology, or are primarily data repository approaches, generally fail to meet KM goals and objectives (Table 1).

The existing IT investments in public agencies like DHS can facilitate knowledge sharing and collaboration with only minor efforts. More dedicated KM technology solutions may require significant investments of funding and time to fully support KM initiatives and programs.

6. KM as Everyday Practices

CHIR’s approach, setting knowledge transfer planning at the start of grant research development, is a model that could apply well for similar DHS Research and Development initiatives. However, it is not widely applicable to DHS as a whole. Conversely, NASA’s focus on embedding KM approaches into everyday practices across the organization. They recognized the conflict between time pressure on projects and the need to capture and share knowledge. Their approaches seek to enable greater productivity and project execution through KM implementation, as opposed to in addition to KM efforts. This change management component was found to be one of the most difficult aspects of implementing a KM framework (Liebowitz J. 2003). While this approach does not directly support either explicit or tacit knowledge sharing, it could be equally applicable depending on the underlying organizational process. However, this would likely be difficult to implement in the short term, since it is dependent on organizational adoption and integration of this approach into existing processes.

7. Connecting the Experts

NASA is still working to manage their explicit knowledge using information management technology. They have also used technology to make it easier to connect the experts. Similar to the challenge with information management, how does KM leverage known knowledge? NASA has developed tools to make it easier to find and connect people based on their knowledge and expertise versus their title or position. In doing so, they have minimized the barrier of not knowing who to talk to. This would be particularly effective to DHS personnel to connect individuals across component agencies or between public and private groups. Connecting the experts is an enabling mechanism for tacit knowledge sharing, as well as collaboration. Based upon the examples studied, implementation is relatively easy and could leverage existing IT infrastructure.

8. Unifying Effort

The GAO designated implementing and transforming DHS as a high-risk area. Given KM's dependency on organizational cultural and collaborative nature, KM could be used as a mechanism to advance DHS's implementation and transformation goal through unity of effort. This concept of unity of effort is specifically called out in the *DHS Quadrennial Homeland Security Review Report – 2010*. This concept is particularly important given the developmental nature of security risk management across the DHS enterprise. Currently, each agency has been forced to interpret and independently implement broad risk management guidance. Consequently, component agencies and other DHS partners have developed risk management tools internally, which has inhibited a national portfolio risk management approach due to incompatible risk assessment methods and practices. KM is a way to more effectively share and jointly develop risk management with greater unity of effort.

Similar to Connecting the Experts, Unity of Effort is an enabling mechanism that could address both explicit and tacit knowledge sharing. While this concept is distinct from collaboration, it would likely manifest through enhanced collaborative efforts. Also like organizational culture, implementation of the Unity of Effort concept would be limited in the short term by organizational adoption challenges.

B. IMPLEMENTATION APPROACHES

1. Cross- Organizational KM Council

Each of the cases studied, as well as the bulk of the literature highlighted, benefits developing a KM Council consisting of members from across the organization. Cross-organizational KM Councils are able to: 1) identify opportunities to apply KM approaches; 2) identify potential KM champions that are receptive and positioned to lead organizational change efforts; 3) compile an organization wide representation of knowledge resources and gaps; and 4) represent the diverse interests of an organization in the drafting of KM strategy, plans, processes, and guidance.

The cross-organizational make up of the KM proved to be a good starting point for collaborative efforts among each of the case studies. Implementing the type of council is generally easy for public agencies, as they generally fit within the organizational structure, often modeled after existing workgroups or advisory councils.

2. Trial and Error or the God Complex?

The interface between organizational culture and KM IT solutions is a complex system. We should not expect to develop a perfect solution from the start. Harford (2011) posits that there is a common theme in successful solutions applied in complex systems, they are built through trial and error. NASA's IT support to their KM initiatives have taken an iterative approach that was able to capitalize on the feedback of users to improve the tool's utility. In NASA's case, their iterative approach fostered collaborative efforts across functional areas as workgroups captured feedback and improved early KM tools. While this type of approach is generally accepted in the short term, there may be push back from the organization, if a trial and error approach fails to yield positive results, or if it is viewed as a constant experiment.

3. Recognize and Promote

Informal recognition and small changes to personnel management practices can positively affect knowledge sharing. In addition to informal recognition, NASA's KM strategic plan identified adding a knowledge sharing component to an employee's performance plan and actively promoting career growth for those who have a history of sharing knowledge and helping others. A review of the literature on economic incentives suggests caution. Lam (2005) identified that small financial rewards did not serve as useful incentives to promote a knowledge sharing culture.

Although recognition and promotion have the potential to enhance collaboration, it could also have the opposite affect if the program is poorly implemented. While NASA enjoyed positive results from their reward program, other instances reviewed in the literature outlined negative perceptions of the program. Recognizing individuals for collaboration or sharing knowledge can be easily combined with existing organizational programs with relatively low cost.

4. The Long View

Building off the spiral development approach NASA has taken for KM IT solutions, they have also adopted a long-view approach for changes within the organizational culture. They recognized at the start of their KM initiative that their organizational culture would need to change for them to transform the agency into a learning organization. These changes did not occur overnight, but many of the initial KM initiatives are still active—some have changed forms as NASA incorporated lessons learned back into their KM initiative. Unfortunately, this approach is not likely to enhance collaboration, since participants may find it difficult to see tangible benefits in the short term. Similarly, from an organizational standpoint, it may be hard to implement a program that does not show immediate benefits.

C. SUMMARY

The KM approaches identified through the appreciative inquiry approach vary in their potential benefits to knowledge sharing and enhancing collaboration. In addition, the implementation feasibility of these approaches varies based on cost, development complexity, and barriers to organizational adoption. Table 3 provides a summary to the findings in relation to the research questions, organized within three categories: (1) whether the approach supports tacit and explicit knowledge; (2) whether the approach is likely to foster greater collaboration between DHS risk management practitioners and (3) implementation feasibility from an organizational standpoint.

KM Approaches	Supports Tacit and Explicit	Potential to Enhance Collaboration	Implementation Feasibility	
			1-2 Years	3-7 Years
Organizational Culture	Both	High	Low	Medium
Starting with KT Strategies	Both	High	High	High
Storytelling and Stories	Tacit	Medium	Medium	High
Communities of Practice	Both	High	High	High
Technology as a Facilitation Tool	Explicit	Medium	Low	Medium
KM as Everyday Practices	Both	Medium	Low	Medium
Connecting the Experts	Tacit	High	Medium	High
Unifying Effort	Both	High	Medium	High
KM Implementation Approaches				
Cross-Organizational KM Council	NA	High	High	High
Trial and Error or the God Complex	NA	Medium	High	Low
Recognize and Promote	NA	High	High	High
The Long View	NA	Low	Low	High

Table 3. Evaluation of KM strategic enablers.

VI. CONCLUSIONS

DHS, as it is currently structured, operates with a functional silo philosophy regarding information management. The current and potential consequences of this include duplication of effort or insufficiently supported decisions based upon a limited subset of the knowledge available across the DHS Enterprise. If DHS's information management systems are to become more integrated, adaptive, and results-oriented, "the silos need to be broken down through the integration of knowledge across" the agency and larger DHS Enterprise (Liebowitz, 2003, p. 69). The database centric KM approaches do not address the predominate factor that moderates the level of knowledge sharing within an organization. To foster increased knowledge sharing and collaboration among security risk management practitioners, DHS will need to address its organizational culture in order for accompanying changes in, IT, and the adoption of KM driven processes to be effective. While this research focused on security risk management practitioners in DHS, the findings about organizational culture have much broader applicability and potential ramifications.

From a KM perspective, DHS in 2011 shares many similarities to the NASA of 2001 (Table 2). Parallels between the two include agencies include the challenge of fully capitalizing on the tacit knowledge of a diverse and geographically distributed workforce; an internal organizational structure defined by functional lines; and the necessity of organized partnering effectively with external entities (private industry, the public, academia, international partners, etc.) for mission execution. The NASA experience offers a potential roadmap for DHS that both models KM implementation and incorporates positive changes to organizational culture.

Although neither the United Kingdom nor Canada KM approaches are fully implemented or perfectly mirror the KM requirements of the United States or DHS, there is value in further exploring their practices. Both the United Kingdom and Canada have implemented KM at a national level with relative success. The United Kingdom system reflects a national implementation and multiple applications all of which align closely

with the needs of the US/DHS (e.g., information security requirements, counter-terrorism application, nexus to e-Government, Transparency, and significant IT integration). There, however, remain challenges regarding effective implementation on more local levels and in achieving cultural change. Conversely, CIHR has made significant progress in integrating KM practices into their agency culture by fostering the creation of new knowledge and the translation of that knowledge from research to real world applications. The CIHR's connection between effective implementation of Knowledge Transfer, funding, and professional recognition also suggests a means of encouraging participation and overcoming known culture challenges to KM implementation. Both countries, therefore, represent routes the United States and DHS can take regarding effective KM implementation and also illustrate the need for organizational change and adaptation in order for KM to be effective.

The KM strategies, policies and implementation mechanisms explored in these case studies are good models for DHS to consider when reducing agencies' uncertainty regarding safety and security risk, aiding decision making and bolstering overall effectiveness. Implementing the Risk Knowledge Management System (RKMS) called for in the DHS Integrated Risk Management Directive will require DHS to find its own routes to overcoming the cultural, process, security, and funding obstacles that will hinder—if not undermine—its efforts if not strategically addressed. By using these case studies as models, reflecting on their experiences, and developing agency specific solutions DHS will be able to effectively implement and adopt proven KM policies on an agency-wide basis.

A. RECOMMENDATIONS

1. U.S. Government

The exploration of the KM literature and case studies of the United Kingdom, Canadian, and NASA KM practices reveal national level benefits that support the 2011 National

Security Strategy goals. The following recommendations regarding national KM implementation are in line with current U.S. strategies for e-Government, innovation, globalization, and knowledge based societies.

- Similar to the United Kingdom, the United States should adopt a national KM strategy integrated with similar international initiatives like those underway in the European Union (FA8).
- Government should support KM efforts within agencies, identify areas where interagency KM can be both cost effective and in the national interest (FA8).

2. DHS

Based on this review of the KM literature and case studies of the United Kingdom, Canadian, and NASA KM practices, DHS should consider the following broad recommendations to enhance KM at the Departmental level.

- Critical assessment of the organizational culture towards knowledge sharing that articulates opportunities and strategies for DHS to become a learning organization (FA1). In this assessment, DHS should identify short-and long-term strategies, ensuring that expectations are managed, and a long-view approach is acceptable for certain goals (FB4).
- DHS should incorporate knowledge sharing into existing recognition and rewards systems, and performance metrics (FB3).
- Similar to the Canadian approach requiring a knowledge transfer element to funded research, the outputs from DHS Centers of Excellence should enable knowledge sharing across the DHS Enterprise (FA2).

- DHS should incorporate KM principles as a functional component of IT management and development. Similar to NASA’s efforts to connect the experts, DHS should enhance the people search functionality of the website DHS Connect to enable searches based on areas of expertise (FA7).
- DHS leadership needs to give consistent and sustaining support to the DHS Risk Management Steering Committee. Maintaining a cohesive and collaborative connection between the two as essential to both organizational change and successful KM implementation efforts across the agency.

3. DHS Risk Management Steering Committee

The DHS Risk Steering Committee charged with implementing the RKMS should consider the following recommendations based on upon this review of the KM literature and case studies of the United Kingdom, Canadian, and NASA KM practices:

- Request to participate in the existing KM Councils to gain additional insight into their smart practices and expand DHS’s opportunities for partnerships and collaboration (FB1).
- Form a DHS KM Council modeled after the existing KM Councils to develop and implement a KM strategy and plan that addresses organizational culture, Knowledge Translation processes, information security requirements, and funding (FA1 & FB1).
- Implement the RKMS through a spiral development approach. This approach allows for reflection in action as the Council can revise RKMS through each iteration to be increasingly effective. The gradual expansion inherent in this approach also contributes to a smoother adaptation of RKMS and, potentially, a desire for as opposed to resistance to RKMS within the number of communities of practice involved (FB2 & FB4).

- Modify DHS contracting regulations to require that copies of all DHS funded reports be submitted electronically to the DHS RKMS and apply KM approaches to integrate this new understanding across the organization. This alone would mitigate nine of the failure factors identified in repository based KM applications (Table 1) (FA6).
- Implement simple and low cost KM approaches to begin to address the organizational culture challenges to knowledge sharing (e.g., storytelling, case studies, and performance reviews, etc.). There should also be a clear statement that the implementers of KM will have the full support of DHS leadership as demonstrated by performance metrics, directives, financial support—sustained support and reinforcement (FA1, FA3, FB3).
- In partnership with DHS Science and Technology Directorate, solicit innovative solutions to KM implementation from such collaborative partners as to academia, existing DHS Centers of Excellence, and industry. These partnerships would also facilitate fully leveraging existing information technology capabilities (FA2 & FA5).
- Encourage and facilitate the development of Communities of Practice by existing DHS risk management workgroups and committees (FA4).
- Formalize storytelling at DHS through a “Brown Bag” lunch series for risk management practitioners and others interested in learning more about existing risk management efforts across the DHS Enterprise. Utilize existing webinar technology to enable personnel outside of DHS Headquarters to participate (FA3 & FA5).

B. AREAS FOR FURTHER RESEARCH

While this research has focused on KM approaches initiated by governments for public agencies and has suggested a number of follow-on actions, more opportunities of study exist for refining the government’s utilization of KM. Studying the private sector’s use of KM in reference to gaining a competitive advantage in business has multiple

applications Follow-on research could explore the applicability of KM programs underway in commercial companies (e.g., Ford, Toyota, BP, Hewlett-Packard, etc.) for potential use by DHS.

In addition to exploring the case studies of private entities, follow-on research could expand upon the utilization of the appreciative inquiry methodology to further explore how KM approaches are working at NASA and CIHR. This study identified KM strategic enablers from existing KM implementations for application in DHS. These findings could form the basis for follow-on research further utilizing the appreciative inquiry methodology. The next logical step would be active research with KM practitioners at NASA and CIHR to include interviews and onsite demonstrations of KM tools to further develop and inform a KM strategy and plan for DHS.

C. SUMMARY

Ultimately, DHS is the government agency responsible for managing domestic risk (terrorist or otherwise) through an enterprise of public and private entities. These entities are interdependent and have overlapping mission priorities, a geographically distributed workforce, and are responsible for both safety and security concerns. This research was initiated with the idea of exploring the idea of KM, as it related to DHS's risk management decision-making process. It has revealed that while KM has the potential to facilitate these efforts within DHS, there needs to be a combination of organizational change and effective implementation in order for it to be successful. Three case studies related to national and international efforts at KM have aided in identifying challenges, pitfalls, and potentials regarding KM as a governmental risk management tool. Implementation of the resulting recommendations will benefit risk management practitioners, enhance DHS's position as a learning organization, and help define the United States as a world leader in the global information society.

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